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A CONVENIENT METHOD FOR THE CONVERSION OF α-TETRALONES TO ARYL ACETATES

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Abstract: A facile synthesis of aryl acetates from α-tetralones has been performed with isopropenyl acetate and *p*-toluenesulfonic acid, followed by dehydrogenation with air or DDQ, in a one-pot procedure.

The conversion of α-tetralones to phenols is usually accomplished by catalytic dehydrogenation over palladium, or dehydrogenation with sulfur or selenium.[1] However, all of these reactions require drastic reaction conditions, and prolonged heating at 220-300 °C is not unusual. Chloranils and 2,3-dichloro-5,6-dicyanoquinone (DDQ) are unable to convert tetralones to phenols, although they are generally useful reagents for dehydrogenation of cyclic compounds. However, enol esters obtained from certain cyclic ketones are readily dehydrogenated to aryl esters with quinones,[1,2] and this constitutes another route for conversion of tetralones to phenols, since the aryl esters are readily hydrolyzed to phenols. It is known that aliphatic ketones can be converted to enol acetates with isopropenyl acetate.[3,4] However, very few examples for tetralones are reported.[2] We present here a general and practical method for conversion of α-tetralones to aryl acetates based on dehydrogenation of enol acetates with air or DDQ.

Method A. The α-tetralones were treated with isopropenyl acetate and a catalytic amount of *p*-toluenesulfonic acid at 85 °C under dry air atmosphere for

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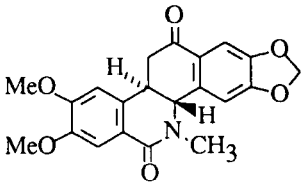
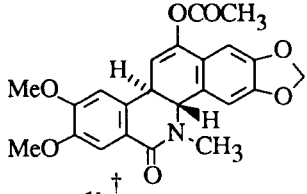
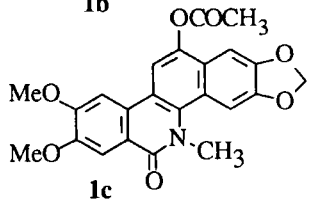
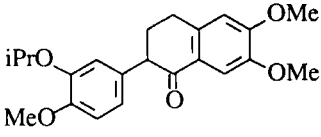
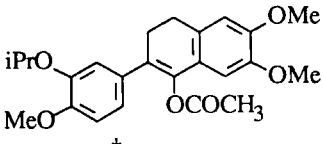
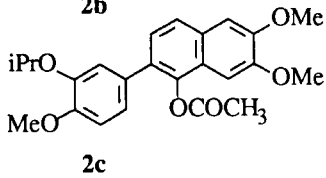
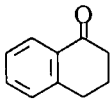
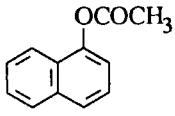
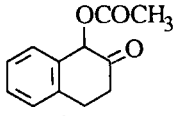
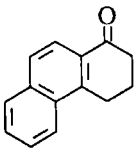
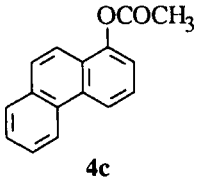
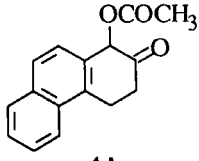
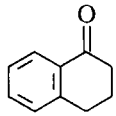
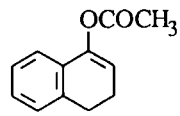
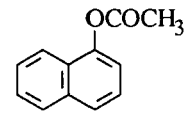
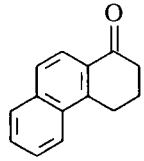
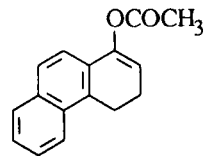
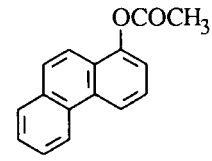
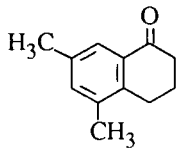
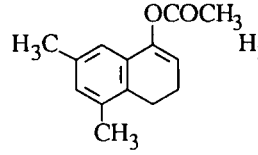
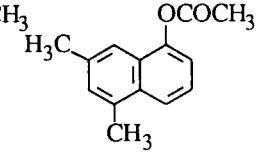
Table 1. Conversion of some α -tetralones to aryl acetates and enol acetates with isopropenyl acetate by Method A

Reactant	Product	Yield %*
 **1a**	 **1b**†	
	 **1c**	84
 **2a**	 **2b**†	
	 **2c**	69
 **3a**	 **3c**	**3c** 22
 **3d**		**3d** 63
 **4a**	 **4c**	**4c** 20
 **4d**		**4d** 62

* Based on the isolated products. † These compounds are intermediates.

Table 2. Conversion of α-tetralones to aryl acetates with isopropenyl acetate and DDQ by Method B

Reactant	enol acetate intermediate	Product	Yield* %
 **3a**	 **3b**	 **3c**	68
 **4a**	 **4b**	 **4c**	77
 **5a**	 **5b**	 **5c**	70

* Based on the isolated aryl acetate.

1-2 days. The results are shown in Table 1. Compounds **1a** and **2a** gave, instead of the intermediate enol acetates **1b** and **2b**, the aryl acetates **1c** and **2c** as the only products. It is apparent that atmospheric oxygen may be responsible for formation of these aryl acetates. When the reaction was run under nitrogen, **1a** was converted to **1b**,[5] the enol acetate, which could be changed to **1c** when heated under air. This seems to be a promising general method for the conversion of 2- and 3-aryl-1-tetralones to phenols. However, when this method was extended to simple tetralones such as **3a** and **4a**, two products were formed, with aryl acetates as the minor products. Here the major products were the 2-tetralone-1-acetates **3d** and **4d**. The isolated product **3c**, 1-naphthyl acetate, suffered no change when it was exposed to air at elevated temperature, whereas the intermediate enol acetate

3b (structure in Table 2), obtained from a reaction under nitrogen, was converted to **3c** and **3d** in a comparable ratio indicated in Table 1. It seems these two products **3c** and **3d** are formed competitively from the enol acetate **3b**, although the mechanism is not known. It appears that Method A is only suitable to 2- and 3-aryl-1-tetralones and not to simple tetralones. Method B, a more general procedure, is applicable to these simple tetralones as described below.

Method B. A one-pot procedure for synthesis of aryl acetates from simple tetralones was devised which involved the conversion of 1-tetralones to enol acetates followed by dehydrogenation with DDQ. After treatment of tetralones with isopropenyl acetate and *p*-toluenesulfonic acid under nitrogen, DDQ was added and the reaction mixtures were heated at 80-90 °C for 90 min. The results are shown in Table 2. The intermediates **3b**, **4b**, and **5b** were isolated and identified by spectroscopic analysis. [5]

In summary, the aryl substituted tetralones, such as **1a** and **2a**, can be readily converted to aryl acetates simply by treatment with isopropenyl acetate under air atmosphere, while simple tetralones can be converted to aryl acetates using isopropenyl acetate and DDQ in a one-pot procedure.

Experimental

Melting points were determined in capillary tubes on a Mel-Temp apparatus and are uncorrected. Chemical ionization mass spectra were obtained on a Finnegan 4000 mass spectrometer. Exact mass measurements were determined on a Kratos MS50 spectrometer. ^{1}H NMR spectra were obtained on a Varian VXR-500S spectrometer with TMS as internal standard in $CDCl_3$. IR spectra were obtained on a Perkin Elmer 1600 Series FTIR spectrometer. Compounds **6**[6] and **7**[7] were prepared previously in our laboratory. 1-Tetralone, 5,7-dimethyl-1-tetralone, 1-phenanthrenone and isopropenyl acetate were purchased from Aldrich Chemical Company and used without further purification.

General Procedure for Method A. The reaction was carried out at 85 °C under a dry air atmosphere in isopropenyl acetate containing *p*-toluenesulfonic acid. The reaction mixture was cooled to room temperature and diluted with methylene chloride or the solvents indicated. The resulting solution was washed with 1M sodium carbonate and water. The organic layer was dried over anhydrous sodium sulfate and concentrated. The residue was chromatographed

on silica gel. Alternatively, the reaction mixture was simply concentrated and chromatographed on silica gel.

12-Acetoxy-8,9-dimethoxy-*N*-methyl-2,3-methylenedioxy-6-oxo-4b,5,6,10b-tetrahydrobenzo[*c*]phenanthridine (1c). A solution of **1a** (3.81 g, 10 mmol) and *p*-toluenesulfonic acid monohydrate (0.95 g, 5 mmol) in isopropenyl acetate (150 mL) was stirred at 85 °C for 48 h. The reaction mixture was diluted with ether and the precipitate (2.52 g) was filtered and washed with ether. The filtrate was concentrated and the residue dissolved in chloroform. The resulting chloroform solution was worked up as described above to give an additional crop of **1c** (1.04 g). Recrystallization from methylene chloride/ethyl acetate afforded an analytically pure sample: mp 275-277 °C; IR (KBr) 2915, 2820, 1757, 1641, 1608, 1502, 1469, 1387, 1362, 1305, 1253, 1205, 1033 cm^{-1}; ^1H NMR δ 2.53 (s, 3 H), 3.95 (s, 3 H), 3.98 (s, 3 H), 4.12 (s, 3 H), 6.07 (s, 2 H), 6.79 (s, 1 H), 7.07 (s, 1 H), 7.19 (s, 1 H), 7.47 (s, 1 H), 7.64 (s, 1 H); CIMS *m/e* (relative intensity) 366 (MH^+, 100), 365 (M^+, 51). HRMS calcd. for $C_{21}H_{19}NO_5$: 366.1341; found: 366.1340.

6,7-Dimethoxy-2-(3'-isopropyloxy-4'-methoxyphenyl)-1-naphthyl Acetate (2c). A solution of **2a** (185 mg, 0.5 mmol) and *p*-toluenesulfonic acid monohydrate (95 mg, 0.5 mmol) in isopropenyl acetate (10 mL) was stirred at 85 °C for 24 h and diluted with ethyl acetate (15 mL). The resulting solution was worked up as described above. Chromatography of the residue using methylene chloride/hexane (1:1) gave 139 mg of **2c** as a solid product: mp 166-168 °C (ethyl acetate/hexane); IR (neat) 2973, 2933, 2839, 1765, 1610, 1505, 1465, 1426, 1370, 1259, 1204, 1159, 1111, 1009 cm^{-1}; ^1H NMR δ 1.39 (s, 3 H), 1.40 (s, 3 H), 2.22 (s, 3 H), 3.91 (s, 3 H), 4.00 (s, 3 H), 4.02 (s, 3 H), 4.56 (m, 1 H), 6.95 (d, J = 9.0 Hz, 1 H), 7.05-7.07 (m, 3H), 7.16 (s, 1 H), 7.36 (d, J = 7.0 Hz, 1 H), 7.64 (d, J = 9.0 Hz, 1 H); CIMS *m/e* (relative intensity) 411 (MH+, 41), 369 (100). HRMS calcd. for $C_{24}H_{27}O_6$: 411.1808; found 411.1800.

1-Naphthyl acetate (3c) and 1-Acetoxy-2-naphthalenone (3d). A solution of 1-tetralone **3a** (150 mg, 1 mmol) and *p*-toluenesulfonic acid monohydrate (20 mg) in isopropenyl acetate (3 mL) was heated at 85 °C for 2 days. The solvent was evaporated and the residue was chromatographed using 30% methylene chloride in hexane to give **3c** (42 mg) as an amorphous solid, which has the same IR and ^1H NMR spectra as an authentic reference,[8] and **3d** (126 mg) as a solid: mp 72-74

°C; IR (KBr) 2957, 2902, 1738, 1700, 1601, 1434, 1377, 1229, 1075, 1045, 1009, 937, 759 cm^{-1}; NMR δ 2.23 (s, 3 H), 2.24-2.33 (m, 2 H), 2.38-2.42 (m, 2 H), 5.55 (q, J = 5 and 14 Hz, 1 H), 7.25-7.28 (m, 1 H), 7.35 (m, 1 H), 7.51 (m, 1 H), 8.03 (m, 1 H); CIMS *m/e* (relative intensity) 205 (MH^+, 100), 163 (25). HRMS calcd. for $C_{12}H_{13}O_3$: 205.0865; found 205.0869.

1-Phenanthryl Acetate (4c) and 1-Acetoxy-2-phenanthrenone (4d). A solution of **4a** (196 mg, 1 mmol) and *p*-toluenesulfonic acid monohydrate (90 mg, 0.5 mmol) in isopropenyl acetate (4 mL) was stirred at 85 °C for two days. The reaction mixture was worked up as described above. Chromatography using methylene chloride and hexane (1:1) gave **4c** (46 mg) as a solid, mp 134 °C, which has the same IR and ^1H NMR spectra as an authentic reference[9] and **4d** (158 mg) as a solid: mp 130-132 °C; IR (KBr) 2961, 2923, 1741, 1679, 1376, 1239, 1180, 1041, 768 cm^{-1}; NMR δ 2.36-2.45 (m, 1 H), 2.58-2.64 (m, 1 H), 3.38-3.45 (m, 1 H), 3.71-3.76 (m, 1 H), 5.67 (dd, J = 5 and 9 Hz, 1 H), 7.61-7.67 (m, 2 H), 7.80 (d, J = 9.0 Hz, 1 H), 7.89 (dd, J = 2 and 7 Hz, 1 H), 8.06 (d, J = 8.5 Hz, 1 H), 8.12 (d, J = 8.5 Hz, 1 H); CIMS *m/e* (relative intensity) 255 (MH^+, 100), 211 (13), 194 (12). HRMS calcd. for $C_{16}H_{15}O_3$: 255.1021; found: 255.1016.

A Typical Procedure for Method B.

5,7-Dimethyl-1-naphthyl acetate (5c). A solution of **5a** (350 mg, 2 mmol) and *p*-toluenesulfonic acid monohydrate (36 mg, 0.2 mmol) in isopropenyl acetate (6 mL) was heated at reflux under nitrogen for 16 h. The reaction mixture was cooled to room temperature and DDQ (1.36 g, 6 mmol) was added. The resulting mixture was stirred at 80 °C for 90 min, diluted with methylene chloride, and washed with 10% sodium hydroxide, 2M HCl, and water. The organic layer was dried over anhydrous sodium sulfate and concentrated. The residue was chromatographed on silica gel using 30% methylene chloride in hexane to give **5c** (280 mg) as a solid: mp 82-84 °C; IR (KBr) 3051, 2945, 2858, 1761, 1603, 1439, 1405, 1367, 1185, 1122, 1009, 924, 850 cm^{-1}; ^1H NMR δ 2.46 (s, 3 H), 2.47 (s, 3 H), 2.66 (s, 3 H), 7.19-7.21 (m, 2 H), 7.42 (t, J = 8.0 Hz, 1 H), 7.48 (s, 1 H), 7.84 (d, J = 8.5 Hz, 1 H); CIMS *m/e* (relative intensity 215 (MH^+, 100), 173 (77). HRMS calcd. for $C_{14}H_{15}O_2$: 215.1072; found: 215.1068.

A Typical Procedure for Separation of Intermediate Enol Acetates.

3,4-Dihydro-1-phenanthryl acetate (4b). A solution of **4a** (400 mg, 0.2 mmol) and *p*-toluenesulfonic acid monohydrate (200 mg, 1.0 mmol) in

isopropenyl acetate (10 mL) was heated at reflux under nitrogen for 18 h. The solution was diluted with ethyl acetate, washed with 2 M sodium carbonate and water, dried over anhydrous sodium sulfate, and concentrated to give 480 mg of **4b** (480 mg) as a solid product: mp 80-82 °C (hexane/methylene chloride); IR (KBr) 3064, 2965, 2877, 1759, 1658, 1360, 1214, 1152, 1127, 1080, 1014, 946, 908, 824, 755 cm^{-1}; NMR δ 2.34 (s, 3 H), 2.57-2.63 (m, 2 H), 3.30 (t, J = 8.5 Hz, 2 H), 5.79 (t, J = 5 Hz, 1 H), 7.31 (d, J = 8.5 Hz, 1 H), 7.45 (d, J = 8 Hz, 1 H), 7.51 (m, 1 H), 7.70 (d, J = 8.5 Hz, 1 H), 7.81 (d, J = 8.5 Hz, 1 H), 8.04 (d, J = 8.5 Hz, 1 H); CIMS *m/e* (relative intensity) 239 (MH^+, 24), 197 (100). HRMS calcd. for $C_{16}H_{15}O_2$: 239.1072; found: 239.1065.

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References

1. Fu, P. P., and Harvey, R. G. *Chem. Reviews* **1978**, *78*, 317.
2. Harvey, R. G., Fu, P. P., Cortez, C., and Pataki, J. *Tetrahedron Lett.* **1977** 3533.
3. Deghenghi, R., and Engel, C. R. *J. Am. Chem. Soc.* **1960**, *82*, 3201.
4. Villotti, R., Ringold, H. J., and Djirassi, C. *J. Am. Chem. Soc.* **1960**, *82*, 5693.
5. **1b**: IR (KBr) 2992, 2934, 2833, 1757, 1647, 1600, 1505, 1483, 1369, 1325, 1289, 1264, 1211, 1094, 1034; ^1H NMR ($CDCl_3$) δ 2.35 (s, 3 H), 3.29 (s, 3 H), 3.96 (s, 3 H), 3.97 (s, 3 H), 4.70 (d, J = 16 Hz, 1 H), 6.02 (AB, J = 1.5 Hz, 2 H), 6.27 (d, J = 2.5 Hz, 1 H), 6.78 (d, J = 6.5 Hz, 1 H), 7.08 (s, 1 H), 7.73 (s, 1 H). HRMS calcd. for $C_{23}H_{21}NO_7$: 424.1396; found: 424.1388. **3b**: IR (neat) 3061, 1756, 1659, 1369, 1338, 1209, 1126, 1076, 1038, 917, 768; ^1H NMR ($CDCl_3$) δ 2.30 (s, 3 H), 2.42-2.50 (m, 2 H), 2.87 (t, J = 8 Hz, 2 H), 5.71 (t, J = 5 Hz, 1 H), 7.08-7.20 (m, 2 H). HRMS calcd. for $C_{12}H_{13}O_2$: 189.0916; found: 189.0912. **5b**: IR (neat) 2935, 2885, 1763, 1659, 1606, 1476, 1439, 1369, 1215, 1164, 1120, 1012; ^1H NMR ($CDCl_3$) δ 2.24 (s, 3H), 2.27 (s, 3 H), 2.30 (s, 3 H), 2.40-2.45 (m, 2 H), 2.77 (t, J = 8.0 Hz, 2 H), 5.66 (t, J = 5.0 Hz, 1 H), 6.77 (s, 1 H), 6.89 (s, 1 H). HRMS calcd. for $C_{14}H_{17}O_2$: 217.1229; found: 217.1222.

6. Cushman, M. and Cheng, L. *J. Org. Chem.* **1978**, *43*, 286.
7. Ishii, H., Chen, I. S., and Ishikawa, T. *J. Chem. Soc. Perkin Trans. I* **1987**, 671.
8. Sadtler Standard N.M.R. Spectra, Vol. 26, 17313M; Sadtler Standard Infrared Prism Spectra, Vol. 44, 44969.
9. Sadtler Standard N.M.R. Spectra, Vol. 74, 41929M; Sadtler Standard Infrared Prism Spectra, Vol. 80, 69032.

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